thermore, in any strict sense, one cannot say that the entropy of any isolated system tends toward a maximum, for the entropy is fixed by the initial conditions and does not change at all. What can be said that comes nearest to the statement of Clausius is that, if a system is regarded as composed of a number of parts, *each of which is large,* the sum of the entropies of the parts tends toward a maximum. When the maximum is reached, the system is in equilibrium with respect to these parts; but without designating such parts the very statement that the system as a whole is in equilibrium is meaningless.

Having proved that equations 11 and 12 are identical with the two primary equations of thermodynamics, the remaining thermodynamic equations may be readily obtained. In a following paper, we shall examine the actual mode of partition into regions in concrete cases, and some of the mathematical methods which may be used for the calculation of the absolute entropy.

[1] These PROCEEDINGS, **14**, 569 (1928).

[2] Since Ω is a positive integer, this definition makes $S \geqq 0$ (the third law). It also conforms with Planck's original suggestion that the entropy is proportional to the logarithm of the number of possible states. There has, however, been much difference of opinion as to the method of computing the number of possible states. We shall discuss at another time the relation between our definition and the latest definition of Planck (*Ber., Berlin. Akad.*, **26-27**, pp. 442 (1925)) as well as the fourth definition of Shrödinger (*Ber. Berlin Akad.*, **26-27**, pp. 434 (1925)).

[3] Lewis, these PROCEEDINGS, **13**, 307 (1927); **13**, 471 (1927).

A PROPOSED EXPERIMENT ON THE NATURE OF LIGHT

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It has long been known that light appears to possess a dualistic character. Many radiation phenomena, such, for example, as interference, receive a rational interpretation by assuming that light consists of electromagnetic waves obeying the Maxwellian equations. On the other side, such experiments as the photo-electric effect show clearly that in the emission or absorption of radiation by matter, the radiant energy appears to be localized in groups or bundles of the magnitude $h\nu$, a conception quite foreign to the wave picture.

A number of rather artificial attempts have been made to reconcile the existence of light quanta with the classical wave theory, but without success, and it has remained for the quantum mechanics to show that both light and matter essentially possess a dualistic character and that no self contradiction is thereby involved. According to this view of the nature of radiation we may say that all questions relating to the mean energy (i.e., the mean number of light quanta) appearing at any point will be correctly answered by the Maxwellian equations. If, on the other hand, we are dealing with individual processes of absorption or emission we shall expect the radiation energy to exist only in discrete bundles of the magnitude $h\nu$, the actual appearance of such bundles being governed by the laws of probability.

As an example of the application of this view we may think of a ray of monochromatic light falling upon a diffraction grating. On a screen some distance away from the grating there will appear a number of spots of light corresponding to the various orders of reflection 0, ± 1, ± 2, etc., where the mean intensity of each spot may be computed in the usual manner by applying the theory of electromagnetic waves. Let us suppose that we possess a suitable means for measuring and recording quantities of radiation as small as $h\nu$ separately. We should then believe that fluctuations of this order of magnitude would be observed at each of the diffraction spots and that these fluctuations would be independent for each spot. This conclusion would present two contradictions to the predictions of the classical wave theory, first, in the existence of discrete quanta of energy and, second, in the independence of the distribution of these quanta over the diffraction spots, for in the wave theory of interference a wave-train of energy $h\nu$ falling on a grating must of necessity be simultaneously distributed over the various orders of reflection. This would however involve a splitting up of the light quantum, contrary to the results of the experiments on the photoelectric effect.

The conclusions that have just been reached concerning the behavior of light at a diffraction grating might be tested experimentally by using as a source of radiation a beam of high frequency x-rays, a crystal lattice as the grating, and a Geiger counter to measure the presence of the light quanta. The beam of x-rays should fall on a single crystal and at the positions of two Laue spots, say of equal intensity, two Geiger counters should be placed. Let the intensity of the original beam be so adjusted by means of filters that only a few light quanta would fall upon each of the counters per minute. If the classical wave theory alone governed the transmission of light, then the absorptions at the two Geiger counters must take place simultaneously since it is essential to this theory that any group of waves, however faint, arriving at a grating will be diffracted to all the orders of reflection simultaneously. If, however, the view presented at the beginning of this note is correct, we may expect that the absorptions at the two counters will be independent and governed only by the laws of probability in such a manner that the mean energy arriving at each spot will be equal to that predicted by means of the wave theory.